TOTAL MAXIMUM DAILY LOAD ASSESSMENT
ILLINOIS GULCH
COUCBL12
Cadmium

SUMMIT COUNTY, COLORADO
March 2011

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<tr><td>Segment 12</td><td>Chronic</td><td>Acute</td></tr>
<tr><td>Cd-D</td><td>(1.101672-[ln(hardness)x(0.041838)]x $e^{0.7998[\ln(hardness0]-4.4451}$</td><td>Trout=(1.136672-[ln(hardness)x(0.041838)]) $xe^{0.9151[\ln(hardness)]-3.6236}$</td></tr>
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EXECUTIVE SUMMARY

Blue River Segment 12, Illinois Gulch, was added the State's 303(d) list of water-quality impaired waterbodies for nonattainment of water quality standards for dissolved cadmium in 2010. Previously, Illinois Gulch had been on the State's 303(d) list for nonattainment of water quality standards for dissolved zinc. A TMDL for zinc was approved in 2010. Excess dissolved cadmium impairs the Aquatic Life Cold 2 classification for Segment 12. The high concentration of dissolved cadmium is primarily the result of mining activity in the watershed since the 1880's. Illinois Gulch is located near Breckenridge in Summit County, Colorado. Water quality in Illinois Gulch above the Iron Springs Gulch (and influence of the Puzzle Mine) is in attainment of assigned standards while water quality below the mine has elevated cadmium levels. Acid mine drainage enters Illinois Gulch via Iron Springs Gulch.

Segment #	Segment Description	Portion	303(d) Listed Contaminants
Blue River Segment 12	Mainstem of Illinois Gulch and Fredonia Gulch from their source to their confluence with the Blue River	Illinois Gulch	Cd

Table 1. Segment within the Blue River watershed that appears on the 2010 303(d) list of impaired water bodies.

II. INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) requires states to periodically submit to the U.S. Environmental Protection Agency (EPA) a list of water bodies that are water-quality impaired. Water-quality limited segments are those water bodies that, for one or more assigned use classifications or standards, the classification or standard is not fully achieved. This list of water bodies is referred to as the "303(d) List". In Colorado, the agency responsible for developing the 303(d) list is the Water Quality Control Division (WQCD). The List is adopted by the Water Quality Control Commission (WQCC) as Regulation No. 93. The WQCC adopted the current 303(d) list March of 2010.

For waterbodies and streams on the 303(d) list a Total Maximum Daily Load (TMDL) is used to determine the maximum amount of a pollutant that a water body may receive and still maintain water quality standards. The TMDL is the sum of the Waste Load Allocation (WLA), which is the load from point source discharge, Load Allocation (LA) which is the load attributed to natural background and/or non-point sources, and a Margin of Safety (MOS) (Equation 1).

(Equation 1) $$TMDL=WLA+LA+MOS$$

Alternatively, a segment or pollutant may be removed from the list if the applicable standard is attained, if implementation of clean-up activities via alternate means will result in attainment of standards, if the original listing decision is shown to be in error or if the standards have been changed as the result of a Use Attainability Analysis (UAA), or other EPA approved recalculation method.

Illinois Gulch is a portion of Segment 12 (the mainstem of Illinois Gulch and Fredonia Gulch from their source to their confluence with the Blue River) and is identified on the 2010 303(d) list for exceeding the water quality standards for dissolved cadmium (Table 1) (WQCC, 2010). The impairment status for designated uses in Illinois Gulch is presented in Table 2.

Date (Cycle Year) of Current Approved 303(d) list: 2010		
WBID	**Segment Description**	**Designated Uses & Impairment Status**
COUCBL12	Mainstem of Illinois Gulch and Fredonia Gulch from their source to their confluence with the Blue River	Aquatic Life Cold 2: Impaired Recreation P: Not Impaired Water Supply: Not Impaired Agriculture: Not Impaired

Table 2. Designated uses and impairment status for Segment 12, Illinois Gulch.

During April 2006, EPA responded to a reported problem in the vicinity of Illinois Gulch. The Puzzle Mine discharged a slug of orange water which flowed through a gulch (named here as Iron Springs Gulch) through Illinois Gulch into Breckenridge. No fish kills were reported to EPA (Hayes Griswold, pers. comm., 2009). Some monitoring was conducted on Illinois Gulch, in the vicinity of the mine, and in the Blue River. However, the data were not used in this assessment. No hardness data were reported for this sampling event and metals were reported as total metals, while the standards are based on the dissolved fraction. It was suspected that an ice dam had formed at the adit, which broke loose during the spring, and released the backed-up water. This type of event has not been observed since then, although there continues to be seepage from the Puzzle Mine.

Geographical Extent

This listed portion of the Blue River Watershed is part of the Colorado River Blue River Basin, Hydrologic Unit Code (HUC) 14010002 and is located in Summit County. Deposits of gold and silver were mined in the watershed beginning in 1870s (Summit Historical Society of Summit County, *www.**summithistorical**.org*).

Illinois Gulch is part of the headwaters reach of the Blue River watershed. The drainage area of Illinois River watershed is 8.08 km^2. The elevation at the mouth of Illinois Gulch is 2932 meters. The mean annual precipitation is approximately 501.14 millimeters. As a headwaters tributary, Illinois Gulch is snowmelt dominated. Heavy metal pollution probably results from a combination of both natural and anthropogenic sources, heavily dominated by acid mine drainage from the Puzzle Mine, a non-active, historical mine site.

Illinois Gulch flows north parallel to Illinois Gulch Road, crosses Boreas Pass Road, flowing northwest where it confluences with Iron Springs Gulch. Iron Springs Gulch seems to originate as seepage near the Puzzle Mine Site, which is located in a large U-shaped curve made by Boreas Pass Road. The Iron Springs Gulch flows in a northerly direction to its confluence with Illinois Gulch. Illinois Gulch continues parallel to Boreas Pass Road, past the Breckenridge Ice Arena and eventually flows into the Blue River.

A map of the study area is shown in Figure 1. Associated sampling sites are marked on the Google Earth photo in Figure 2.

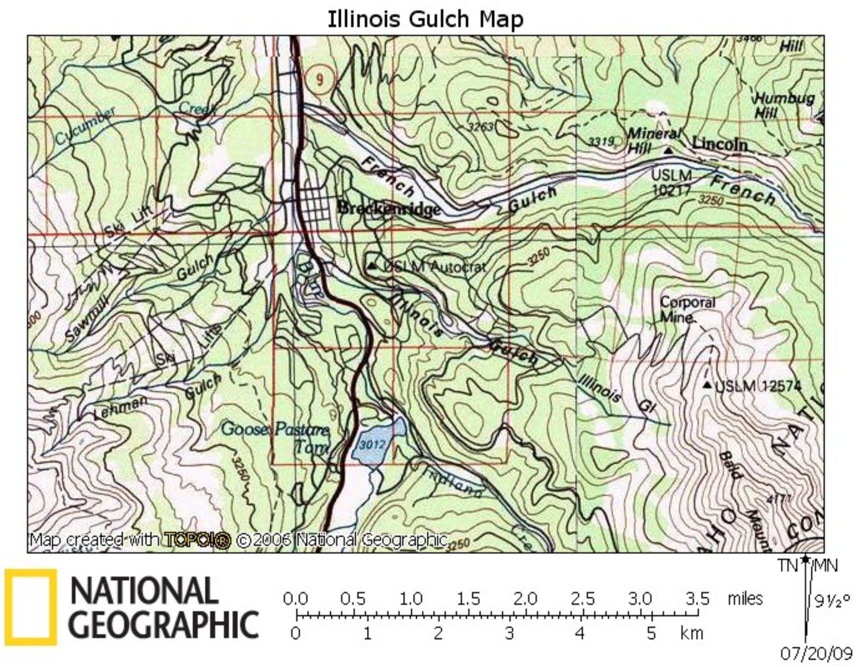

Figure 1. Illinois Gulch

Figure 2. Google Earth image of Illinois Gulch monitoring locations.

III. WATER QUALITY STANDARDS

Standards Framework

Waterbodies in Colorado are divided into discrete units or "segments". The Colorado *Basic Standards and Methodologies for Surface Water*, Regulation 31(WQCC 2011), discusses segmentation of waterbodies in terms of several broad considerations:

> *31.6(4)(b)…Segments may constitute a specified stretch of a river mainstem, a specific tributary, a specific lake or reservoir, or a generally defined grouping of waters within the basin (e.g., a specific mainstem segment and all tributaries flowing into that mainstem segment).*

> *(c) Segments shall generally be delineated according to the points at which the use, physical characteristics or water quality characteristics of a watercourse are determined to change significantly enough to require a change in use classifications and/or water quality standards*

As noted in paragraph 31.6(4)(c), the use or uses of surface waters are an important consideration with respect to segmentation. In Colorado there are four categories of beneficial use which are recognized. These include Aquatic Life Use, Recreational Use, Agricultural Use and Water Supply Use. A segment may be designated for any or all of these "Use Classifications":

> *31.6 Waters shall be classified for the present beneficial uses of the water or the beneficial uses that may be reasonably expected in the future for which the water is suitable in its present condition or the beneficial uses for which it is to become suitable as a goal.*

Each assigned use is associated with a series of pollutant specific numeric standards. These pollutants may vary and are relevant to a given Classified Use. Numeric pollutant criteria are identified in sections 31.11 and 31.16 of the *Basic Standards and Methodologies for Surface Water.*

Uses and Standards Addressed in this TMDL

The Colorado Basic Standards and Methodologies for Surface Water, Regulation 31 identifies standards applicable to all surface waters statewide (WQCC 2011). The pollutant of concern for this assessment is dissolved cadmium. In the case of Illinois Gulch, cadmium concentrations exceed Aquatic Life Use-based standards intended to protect against short-term, acutely toxic conditions (acute) and longer-term, sub-lethal (chronic) effects.

Chronic and acute standards are designed to protect against different ecological effects of pollutants (long term exposure to relatively lower pollutant concentrations vs. short term exposure to relatively higher pollutant concentrations). Where chronic standards are assigned, they are used because they represent a more conservative approach than the acute standards. Chronic standards represent the level of pollutants that protect 95 percent of the genera from chronic toxic effects of metals. By reducing metals concentrations to attain the chronic standard, the acute standard will also be attained. Per Regulation 31, chronic toxic effects include but are not limited to demonstrable abnormalities and adverse effects on survival, growth, or reproduction (WQCC 2011).

The specific numeric standards assigned to the listed stream segments are contained in Regulation 33, the Classifications and Numeric Standards for Upper Colorado River Basin and North Platte River (Planning Region 12) (WQCC, 2010) (Table 3). In addition to the dissolved zinc, for which a TMDL has been approved, Illinois Gulch is 303(d) listed for dissolved cadmium (aquatic life use-based acute (trout) and chronic standards) on the 2010 303(d) list. All remaining assigned numeric standards associated with Aquatic Life, Recreational, Water Supply and Agricultural Use Classifications are attained.

Water Quality Criteria for Impaired Designated Uses		
WBID	**Impaired Designated Use**	**Applicable Water Quality Criteria and Status**
COUCBL12	Aquatic Life Cold 2	Dissolved Phase Cd (1) / Not Attained
Applicable State or Federal Regulations: (1) Classifications and Numeric Standards for Upper Colorado River Basin and North Platte River (Planning Region 12), (Regulation No. 33)		

Table 3. Ambient water quality criteria and status for Segment 12, Illinois Gulch.

The relevant standards for the stream segment addressed in this document are Table Value Standards (TVS), which vary based on hardness. Hardness fluctuates seasonally, therefore, standards are shown for low-flow and high-flow seasons (Table 4). The low-flow season is from September through April, while the high-flow season was from May through August. Aquatic Life Use-based metals standards, identified as Table Value Standards or "TVS", are typically hardness based (arsenic, mercury and selenium are exceptions). Aquatic Life Use-based TVS for metals usually are expressed as the dissolved fraction, as opposed to the total metal fraction. Again, there are exceptions, namely aluminum, iron and, again, mercury. Cadmium standards assigned for the protection of aquatic life are expressed as the dissolved metal fraction and are hardness based. The hardness values are the average of data from all sites in the study.

Season	Hardness mg/L	Cd-D, ug/L TVS (ch)	Cd-D ug/L TVS (ac-tr)
Low-flow	130.5	0.52	2.15
High-flow	113.1	0.47	1.90

Table 4. Average hardness and table value standards (chronic and acute) for 303(d) listed segment of Illinois Gulch. Data are from the Colorado Water Quality Control Division.

IV. PROBLEM IDENTIFICATION

Much of the heavy metal loading throughout the Blue River basin is the result of natural geologic conditions and historic mining activities. The Blue River watershed began experiencing widespread mining activity throughout the basin beginning in the 1870's. Several historical mine sites are located in the vicinity of Illinois Gulch. The Puzzle Mine site is located inside of a large curve (north side of road) made by Boreas Pass Road just before Illinois Gulch Road. Commodities from the mine included gold, zinc, lead, silver, and copper. Mining operations resulted in residual levels of elevated cadmium concentrations in Illinois Gulch. Seepage from the mine site enters a gulch, named here as Iron Springs Gulch, which is tributary to Illinois Gulch. There are no permitted dischargers to Illinois Gulch.

The high metals concentrations in Illinois Gulch exceed the standards to protect aquatic life.

V. WATER-QUALITY GOAL AND TARGET

The water quality goal for the 303(d) listed segment, Illinois Gulch, is attainment of the Aquatic Life Cold 2 use classification standards for dissolved cadmium.

VI. INSTREAM CONDITIONS

Hydrology

The hydrograph of the Blue River (Figure 2) should approximate the pattern of the Illinois Gulch hydrograph, although at a larger magnitude. Such hydrographs are typical of high mountain streams, with low flows occurring in the late fall to early spring followed by a large increase in flow, usually in May or June, due to snowmelt that tails off through the summer (Figure 3, Table 5).

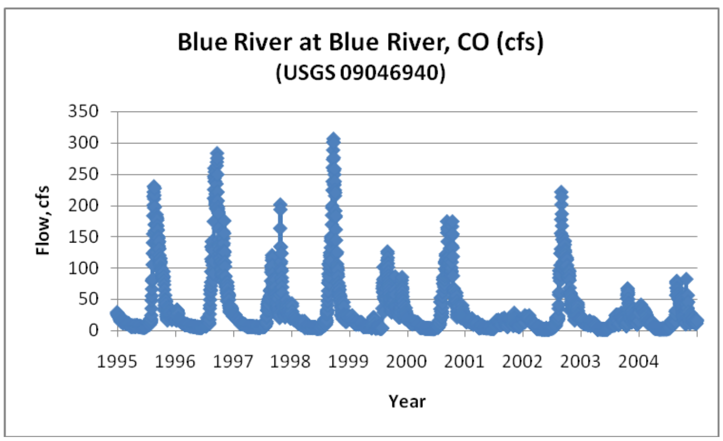

Figure 2. Hydrograph of Blue River at Blue River, CO, USGS gage 09046940.

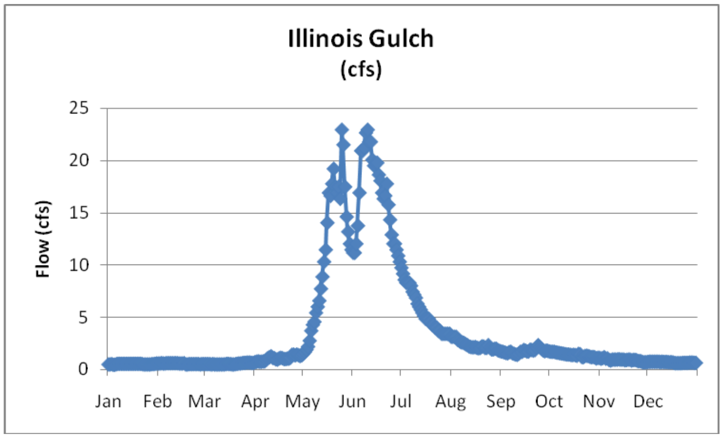

Figure 3. Annual hydrograph for Illinois Gulch

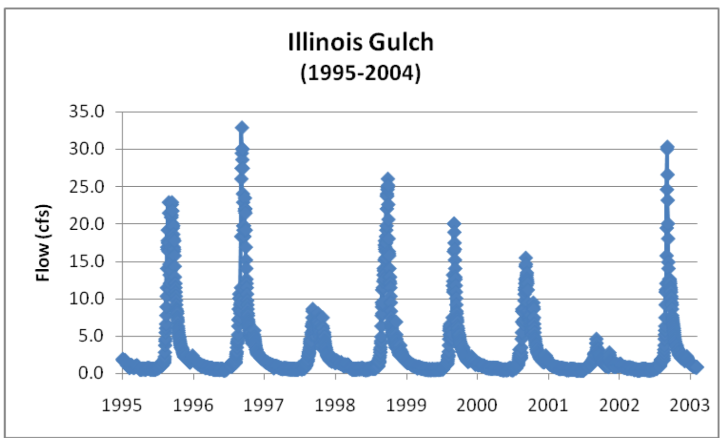

Figure 4. Hydrograph of Illinois Gulch modeled from Blue River data.

	Monthly Median. Flow Illinois Gulch. (cfs)
Jan	0.36
Feb	0.30
Mar	0.29
Apr	0.57
May	3.46
Jun	7.43
Jul	4.12
Aug	2.13
Sep	1.47
Oct	1.25
Nov	0.96
Dec	0.74

Table 5. Estimated monthly median flows (cfs), for Illinois Gulch.

Flows for the Blue River were obtained from USGS gage #09046940 near Blue River, Colorado. Illinois Gulch flows were estimated using a watershed area ratio (0.074) and applying the ratio to the data from the Blue River gage (Figure 4). Median monthly flows in the Blue River were between four and one hundred eleven cubic feet per second (cfs) based on instantaneous and estimated flows. Estimated median monthly flows for Illinois Gulch were between 0.3 and 8 cfs (Table 5).

The distribution of flows for Illinois Gulch throughout the annual cycle is illustrated in a "box and whiskers" plot (Figure 3). The boxes show the 25th and 75th percentiles, while the bars or whiskers show the 5th and 95th percentiles for the flow estimates. Medians are shown as markers in the boxes. The period of record from 1995 through 2010 was used. Higher flows are observed during May through August. Figure 4 illustrates the distribution of flows comparing the high-flow season (May through August) with low flow (September through April). Median flows for high-flow and low-flow conditions were 3.53 cfs and 0.72 cfs, respectively.

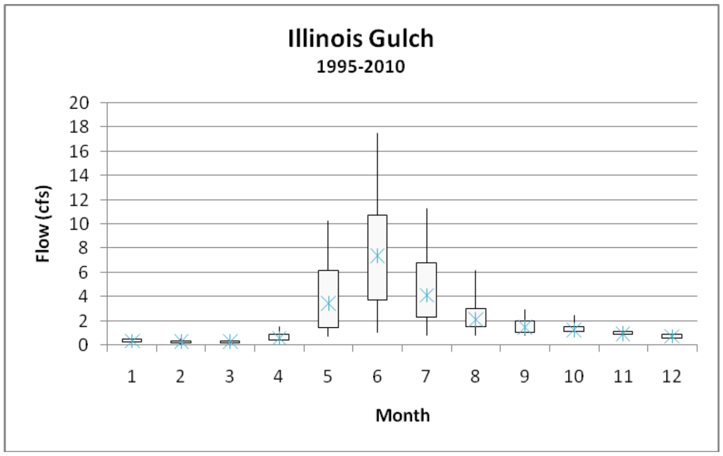

Figure 3. Distribution of flows in Illinois Gulch (by month)

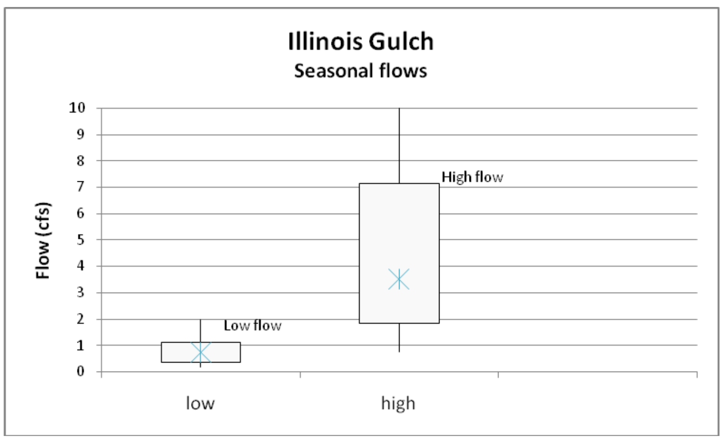

Figure 4. Distribution of flows in Illinois Gulch (low flow vs. high flow)

VII. ANALYSIS OF POLLUTANT SOURCES

Ambient Water Quality Data

Water quality data were collected at one site (Illinois Gulch at the Breckenridge Ice Rink) during routine monitoring by the Colorado Water Quality Control Division (WQCD) from 2001-2007. The WQCD conducted synoptic sampling events; 2 during 2008 and 2 during 2010. Six sites were sampled: sample sites were located upstream from the Puzzle

Mine (Illinois Gulch at Illinois Gulch Road), the Puzzle Mine seepage, Iron Springs Gulch upstream from the confluence with Illinois Gulch, Illinois Gulch upstream of the confluence with Iron Springs Gulch, Illinois Gulch downstream of the confluence with Iron Springs Gulch, and Illinois Gulch at the Breckenridge Ice Rink. The sample sites are shown on the map in Figure 2. The cadmium data collected during October 2008 were suspect, and therefore not included in this assessment. Table 6 presents an assessment of the Illinois Gulch data with all sites pooled.

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Illinois Gulch	Hardness (mean) mg/L	Cd-D (ug/L)	n
Illinois Gulch data	121.8	3.8	30
Table Value Standards (chronic)		0.49	

Table 6. Illinois Gulch ambient data summary, (POR = 2001-2007, 2008, 2010).

A summary of the data from each site is shown in Table 7. Means are presented for hardness and 85th percentiles are presented for cadmium for each site. Sites are ordered from upstream to downstream, and show clearly the influence that the Puzzle Mine and Iron Springs Gulch sites have on Illinois Gulch. The two Illinois Gulch sites upstream from the those sites represent background conditions. The dissolved cadmium at these background sites were below water quality standards, while the Puzzle Mine Seepage and Iron Springs Gulch sites, as well as the Illinois Gulch sites downstream from Iron Springs exceeded water quality standards.

Illinois Gulch at Breckenridge Ice Rink is located near the mouth of Illinois Gulch and represents the most downstream site in this data set. The routine monitoring data were collected at this site and it has the longest period of record. Figure 5 illustrates the temporal variability in the cadmium concentrations in Illinois Gulch. The synoptic data from 2008 and 2010 illustrate spatial patterns in the system (Figure 6) and demonstrate that dissolved cadmium concentrations attenuate with distance downstream from the source.

Sampling Sites	Hardness (mean) mg/L	Cd-D (85^{th} percentile) ug/L	n
Illinois Gulch at Illinois Gulch Road (WQCD = 12364F)	77	0	3
Illinois Gulch upstream Iron Springs Gulch (WQCD = 12365D)	75	0	3
Puzzle Mine Seepage (12364B)	227	59.7	3
Iron Springs Gulch upstream Illinois Gulch (WQCD =12364E)	160	6.6	3
Illinois Gulch downstream Iron Springs Gulch (WQCD=12365C)	90	1.6	3
Illinois Gulch at Breckenridge Ice Rink (WQCD=12364)	118	1.4	14
Table Value Standards (chronic)	113	0.47	

Table 7. Illinois Gulch ambient data summary, by site (POR = 2001-2007, 2008, 2010). Sites are ordered upstream to downstream. Table Value Standards based on data for sites downstream from Iron Springs Gulch.

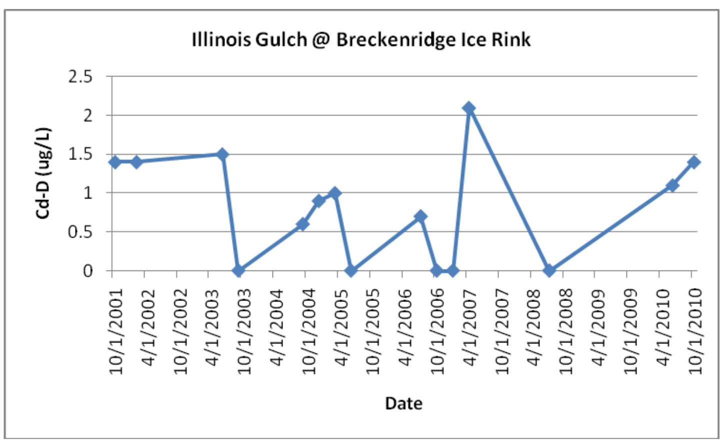

Figure 5. Temporal pattern of dissolved cadmium for Illinois Gulch at Breckenridge Ice Rink (2001-2007, 2008, 2010).

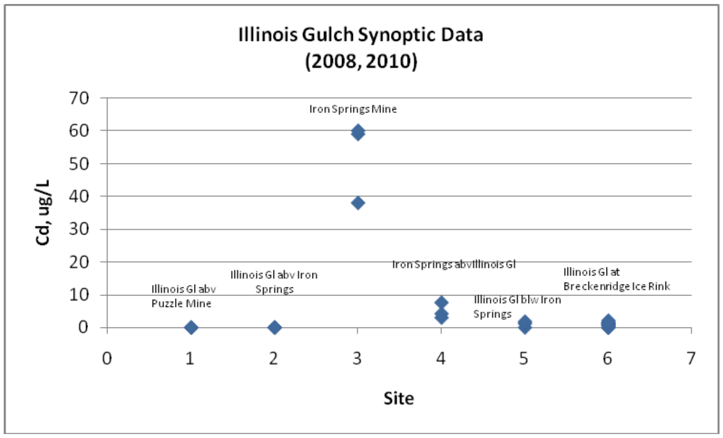

Figure 6. Illinois Gulch Synoptic data (2008, 2010), by site. Sites are ordered, upstream to downstream, as in Table 6.

Chronic Standards

Ambient water quality was determined using the WQCD data described above. For this analysis, two sites upstream from the Puzzle Mine seepage represent background conditions. This background is represented by 3 sampling events conducted during 2008 and 2010. The data from these sampling events showed cadmium concentrations were less than detection level; <0.6 ug/L. The approach typically used in State of Colorado water quality assessments is to assign a value of 0 for data results of less than detection. This is the approach applied here.

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Data from the remaining sites, Puzzle Mine, Iron Springs Gulch, and the Illinois Gulch sites downstream from the Iron Springs Gulch, were used to characterize exceedances of the chronic water-quality standards for cadmium. Attainment of chronic Aquatic Life Use-based standards is based upon the 85th percentile of the ranked data. The metals standards are Table Value Standards (TVS) expressed as hardness-based equations. Hardness-based metal standards are evaluated by comparing the 85th percentile value against the assigned hardness-based standard, typically calculated using the mean hardness (Table 8).

Sampling Sites	Hardness (mean) mg/L	Cd-D (85^{th} percentile) ug/L	TVS	n
Puzzle Mine Seepage (12364B)	227	59.7	0.79	3
Iron Springs Gulch upstream Illinois Gulch (WQCD =12364E)	160	6.6	0.60	3
Illinois Gulch downstream Iron Springs Gulch (WQCD=12365C)	90	1.6	0.39	3
Illinois Gulch at Breckenridge Ice Rink (WQCD=12364)	118	1.4	0.48	14

Table 8. Illinois Gulch (sites downstream Iron Springs Gulch) assessment, (POR = 2001-2007, 2008, 2010).

The data also were evaluated using low-flow and high flow seasons. The low-flow and high-flow conditions were determined, and mean hardness values for each were used to calculate the TVS. Table 9 is based on Illinois Gulch sites downstream from Iron Springs Gulch. Table 10 is based on the Puzzle Mine Seepage and Table 11 is based on the Iron Springs Gulch site.

Illinois Gulch			
	Hardness	Cd-D, TVS (ch)	Cd-D (n=16
Low	130	0.52	1.6
High	87	0.38	1.2

Table 9. Illinois Gulch dissolved cadmium exceedances based on hydrologic condition. Ambient concentrations are calculated as 85^{th} %.

Puzzle Mine Seepage			
	Hardness	Cd-D, TVS (ch)	Cd-D
Low	200	0.72	38 (n=1)
High	240	0.82	60 (n=2)

Table 10. Puzzle Mine Seepage dissolved cadmium exceedances based on hydrologic condition. Ambient concentrations are calculated as means.

Iron Springs Gulch			
	Hardness	Cd-D, TVS (ch)	Cd-D
Low	160	0.60	1.8 (n=1)
High	160	0.60	1.2 (n=2)

Table 11. Iron Springs Gulch dissolved cadmium exceedances based on hydrologic condition. Ambient concentrations are calculated as means.

Load Duration Curves

Load duration curves are graphical analytical tools that illustrate the relationships between stream flow and water quality. Flow is an important factor affecting the loading and concentration of metals. Load duration curves are used to characterize water quality data at different flow regimes. A load duration curve consists of a curve that represents the water quality standard of interest and is developed by multiplying stream flow with the numeric water quality target and a conversion factor for the pollutant of concern. This curve, the load duration curve, plotted as a continuous line, represents the loading capacity or allowable load for the water body. Ambient water quality data, taken with a flow measurement associated with the time of sampling, for example, daily mean flow, is used to compute an instantaneous load. By plotting the instantaneous loads with the load duration curve, characteristics of water quality impairment can be described. Instantaneous loads that plot above the curve indicate exceedance of the water quality criterion, while loads that plot below the load duration curve illustrate compliance. The pattern of impairment is examined to see if impairments occur across all flow conditions or under certain flow regimes. For example, impairments observed in the low flow zone typically indicate the influence of point sources, while impairments toward the left side of the curve (i.e., high flow zone) typically reflect nonpoint source contributions.

A cadmium load duration curve for Illinois Gulch was constructed to provide further illustration comparing loads to the standard across all hydrologic conditions (Figure 7). Cadmium exceedances are observed across most flow conditions, which suggest pollutant contributions from groundwater sources, point sources, and additional nonpoint sources from mining features. No data fall under the High Flow category due to the small data set for this study. Very few samples were actually collected under each of the different hydrologic conditions. However, the exceedances occurring under the range of flow conditions observed suggest a continually discharging point source.

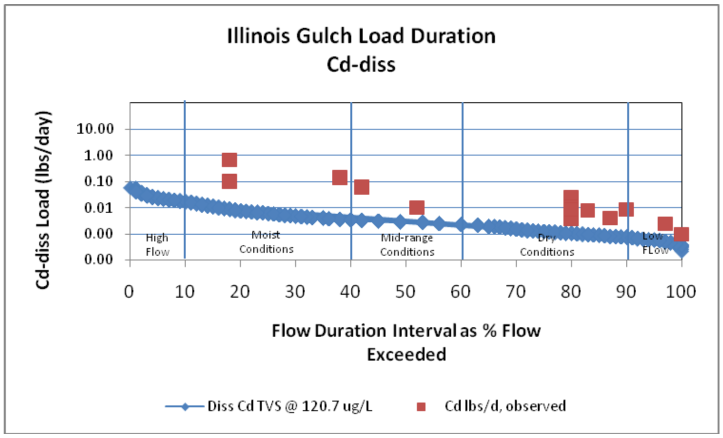

Figure 7. Load duration curve for dissolved cadmium.

Acute Standards

Acute standards are evaluated by comparison of single sample values to standard. The standard is calculated for each sampling event based upon the discrete, sample specific hardness. Data indicate non-attainment of an acute standard if the standard is exceeded more frequently than once in three years.

Attainment of the acute standards for cadmium was assessed for the data from Illinois Gulch sites upstream and downstream from Iron Springs sources, as well as the Iron Springs samples. For this assessment, only samples with paired hardness and cadmium were used. Acute standards for cadmium were attained for the Illinois Gulch sites upstream from Iron Springs. The Puzzle Mine Seepage and Iron Springs Gulch both exceed acute standards for all samples. Illinois Gulch downstream Iron Springs Gulch exceeds the acute cadmium standard during low flow. However, all other samples for sites downstream of Iron Springs Gulch attain the acute cadmium standard (Table 10).

station #	station name	date	Hardness, mg/L	Cd-TVS (Ac-tr)	Cd-D, ug/L amb	Exceedance
12364F	ILLINOIS GULCH @ ILLINOIS GULCH ROAD	7/24/2008	74	1.31	0	no
12364F	ILLINOIS GULCH @ ILLINOIS GULCH ROAD	6/10/2010	65	1.17	0	no
12364F	ILLINOIS GULCH @ ILLINOIS GULCH ROAD	10/14/2010	91	1.57	0	no
12364B	PUZZLE MINE SEEPAGE	7/24/2008	230	3.51	59	yes
12364B	PUZZLE MINE SEEPAGE	6/10/2010	250	3.78	60	yes
12364B	PUZZLE MINE SEEPAGE	10/14/2010	200	3.11	38	yes
12364D	ILLINOIS GULCH UPSTREAM IRON SPRINGS GULCH	7/24/2008	82	1.43	0	no
12364D	ILLINOIS GULCH UPSTREAM IRON SPRINGS GULCH	6/10/2010	65	1.17	0	no
12364D	ILLINOIS GULCH UPSTREAM IRON SPRINGS GULCH	10/14/2010	77	1.36	0	no
12364E	IRON SPRINGS GULCH UPSTREAM ILLINOIS GULCH	7/24/2008	170	2.70	3	yes
12364E	IRON SPRINGS GULCH UPSTREAM ILLINOIS GULCH	6/10/2010	150	2.42	7.6	yes
12364E	IRON SPRINGS GULCH UPSTREAM ILLINOIS GULCH	10/14/2010	160	2.56	4.2	yes
12364C	ILLINOIS GULCH BELOW IRON SPRINGS GULCH	7/24/2008	94	1.61	0	no
12364C	ILLINOIS GULCH BELOW IRON SPRINGS GULCH	6/10/2010	76	1.34	1.2	no
12364C	ILLINOIS GULCH BELOW IRON SPRINGS GULCH	10/14/2010	100	1.70	1.8	yes
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	10/30/2001	120	2.00	1.4	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	2/6/2002	130	2.14	1.4	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	6/30/2003	89	1.54	1.5	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	9/9/2003	130	2.14	0	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	9/29/2004	120	2.00	0.6	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	12/21/2004	180	2.84	0.9	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	3/17/2005	170	2.70	1	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	6/6/2005	83	1.45	0	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	7/27/2006	100	1.70	0.7	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	10/12/2006	120	2.00	0	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	1/9/2007	120	2.00	0	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	4/11/2007	140	2.28	2.1	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	7/24/2008	95	1.63	0	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	6/10/2010	74	1.31	1.1	no
12364	ILLINOIS GULCH @ BRECKENRIDGE ICE RINK	10/14/2010	100	1.70	1.4	no

Table 10. Illinois Gulch assessment of exceedances of acute cadmium standards.

VIII. TMDL Allocation

A TMDL is comprised of the Load Allocation (LA), which is that portion of the pollutant load attributed to natural background and/or the nonpoint sources, the Waste Load Allocation (WLA), which is that portion of the pollutant load associated with point source discharges, and a Margin of Safety (MOS). The TMDL may be expressed as the sum of the

LA, WLA and MOS.

$$TMDL = WLA + LA + MOS$$

TMDL = Sum of Waste Load Allocations + Sum of Load Allocations + Margin of Safety

Waste Load Allocations "(WLA)"

There are no identified permitted point sources to this segment. The only source found was the Puzzle Mine Seepage to the Iron Springs Gulch; however there is no CPDES permit for the mine. Limited data for flows and point source water quality were available. Discharge from the mine will be treated as a non-permitted discharge in this TMDL and will be given a waste load allocation.

Load Allocations "(LA)"

Any remaining sources are considered to be non-point sources and are accountable to load allocations.

Margin of Safety "(MOS)"

According to the Federal Clean Water Act, TMDLs require a margin of safety (MOS) component that accounts for the uncertainty about the relationship between the pollutant loads and the receiving waterbody. The margin of safety may be explicit (a separate value in the TMDL) or implicit (included in factors determining the TMDL). In the case of the Illinois Gulch TMDL, a 10% margin of safety was used. As a result, proposed reductions also address exceedances of the acute standards assigned to the listed segment.

The TMDL is calculated using median flows for high-flow and low-flow seasons (estimated from USGS gage #09046940 as described in section VI above), multiplied by the existing stream standard and a conversion factor (0.0054) to approximate a load in pounds/day. This load is reduced by 10% to reflect the margin of safety (MOS). The resulting load is allocated between background nonpoint source for the Load Allocation and the discrete and diffuse sources at the Puzzle Mine site for the Waste Load Allocation.

Observed loads are calculated using eighty-fifth percentile concentrations which are calculated on a flow-season basis and multiplied by corresponding seasonal median flows and a conversion factor (0.0054) to estimate a daily load in pounds/day. Reductions are calculated as the difference between the observed load and the TMDL Load with the 10% MOS.

The TMDL allocations (LA and WLA) are determined by calculating the contribution from background and attributing the remainder to mining influences. Background is the average of the concentrations from the upstream sites. The water quality at these sites was below detection levels for cadmium. The assigned background concentration for cadmium was zero for both flow conditions. Therefore, the LA for cadmium will be 0. The observed loads of cadmium at the downstream site are attributed to mining influence, and the entire cadmium TMDL is allocated to the WLA. TMDLs were calculated for the Iron Springs Gulch upstream Illinois Gulch Confluence and for Illinois Gulch downstream Iron Springs Gulch. Implementation of the TMDL will result in attainment of dissolved cadmium standards at all downstream sites.

TMDL Site	Flow Condition	Cd-D Observed Load	TMDL Load	MOS	TMDL Load (w/10% MOS)	Reduction	Reduction	TMDL LA	TMDL WLA
		(lbs/D)	(lbs/D)	(lbs/D)	(lbs/D)	(lbs/D)	%	(lbs/D)	(lbs/D)
IRON SPRINGS GULCH UPSTREAM ILLINOIS GULCH	Low	0.02	0.0023	0.0002	0.0021	0.0143	87%	0.00	0.0021
IRON SPRINGS GULCH UPSTREAM ILLINOIS GULCH	High	0.1	0.0114	0.0011	0.0103	0.0908	90%	0.00	0.0103
Illinois Gl blw Iron Springs Gl	Low	0.01	0.002	0.0002	0.0018	0.0044	71%	0.00	0.0018
Illinois Gl blw Iron Springs Gl	High	0.02	0.0073	0.0007	0.0066	0.0169	72%	0.00	0.0066

Table 11. Cd TMDL and Load Reduction by flow condition (includes 10% MOS) Segment: COUCBL12. Illinois Gulch

Acute Standards

Attainment of acute standards was evaluated by applying the reduction percentages identified in the table above to individual samples. The reductions resulted in attainment of the acute standards.

IX. RESTORATION PLANNING AND IMPLEMENTATION PROCESS

The monthly percentages of loading reduction necessary to meet TVS standards for cadmium on Illinois Gulch are listed in Table 11. The major source contributing to the elevated level of metals in Illinois Gulch is the Puzzle Mine and non-permitted discharge from the Puzzle Mine property. A substantial reduction of metals from this non-permitted point source is necessary to attain current TVS standards in Illinois Gulch. There is no known cadmium remediation planned for Illinois Gulch.

Monitoring

Additional monitoring of Illinois Gulch beyond routine monitoring performed by the WQCD is not planned at this time. If remediation for cadmium is implemented, monitoring of Illinois Gulch should be required in order to ensure that the TMDL is adequately protective of the segment. Additional water quality and flow monitoring of the drainage from the Puzzle Mine as well as from Illinois Gulch upstream and downstream of the mine would be included for comprehensive monitoring for any remediation efforts.

Conclusion

The goal of this TMDL is the attainment of the TVS for cadmium within the Illinois Gulch portion of Segment 12 of the Blue River. Substantial loading reductions of cadmium are necessary to attain the TMDL for each metal. The recommended loading reductions should result in attainment of both chronic and acute water quality standards.

X. PUBLIC INVOLVEMENT

This segment was included on Colorado's 303(d) list of impaired segments in 2010. The development of the 303(d) list is a public process involving solicitation from the public of candidate waterbodies, formation of a technical review committee comprised of representatives of both the public and private sector, and a public hearing before the Colorado Water Quality Control Commission. Public notice is provided concerning both the solicitation of impaired waterbodies and the public hearing.

The TMDL itself is the subject of an independent public process. This TMDL report was made available for public review and comment during a 30 day public notice period in April 2011. The EPA provided minimal comments on the draft TMDL. The EPA comments included requests for raw data used in the TMDL analysis, and identification of public notice comments. The WQCD received _______ comments during the public notice period.

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